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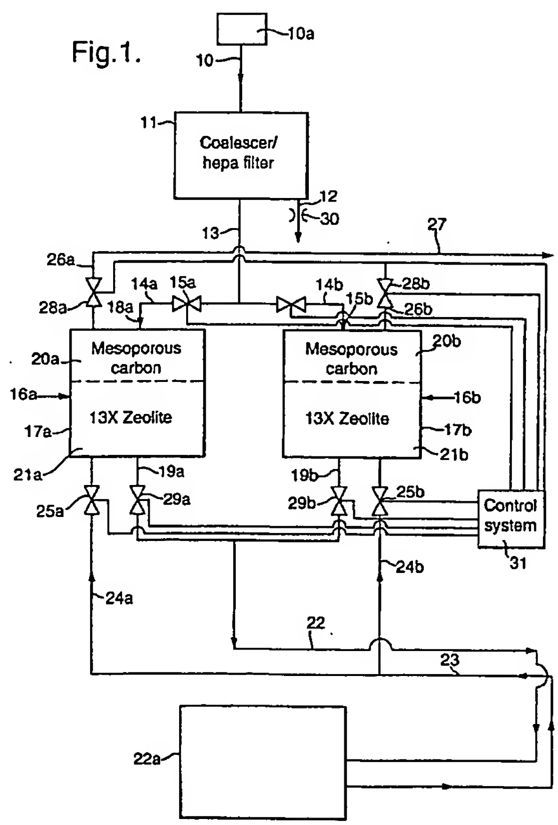
(54) Method and system for removing chemical and biological agents from air

(57) In the removal of chemical and biological agents from air, the air is passed through a pressure swing adsorber including a layer mesoporous carbon (20) and then a 13X Zeolite 21. The mesoporous carbon filter (20) removes higher boiling point agents and the 13X Zeolite (21) removes lower boiling point agents.

Fig.1.



EP 1 155 729 A1

Description

[0001] The invention relates to the removal of chemical and biological agents from air and in particular to such removal from air for breathing by humans.

[0002] The removal of chemical and biological agents from air for breathing by humans has long been a problem. GB-A-2238490 contains a discussion of previously known methods and systems for such removal. GB-A-2238490 proposes a system for the removal of such agents including compressing the air, purifying the compressed air in a pressure swing adsorber and filtering the compressed air through a filter intercepting particulates.

[0003] Such systems have been successful in removing a wide variety of chemical and biological agents. The invention seeks to provide an improved system of this general type.

[0004] According to a first aspect of the invention, there is provided a method of removing chemical and biological agents from air for breathing by humans comprising removing higher boiling point agents from the air and then passing the air through an adsorbent in a pressure swing adsorber to remove lower boiling point agents and water vapour.

[0005] According to a second aspect of the invention, there is provided a system for removing chemical and biological agents from air for breathing by humans comprising means for removing higher boiling point agents from the air and a pressure swing adsorber for receiving air from the removing means and including an adsorbent for removing lower boiling point agents and water vapour from the air.

[0006] The following is a more detailed description of an embodiment of the invention, by way of example, reference being made to the accompanying drawings in which: -

Figure 1 is a schematic representation of a system for removing chemical and biological agents from air for breathing by humans,

Figure 2 is a plan view from above of a combined coalescer and filter incorporated in the filter of Figure 1 and,

Figure 3 is a section on the line A -A of Figure 2.

[0007] Referring to the drawing, the system comprises a compressed air inlet 10 that leads from a source of compressed air 10a. This source 10a may, for example, be a dedicated turbine or may be an air bleed in the case where, for example, the apparatus is used in an aircraft or other system having a power source producing compressed air.

[0008] In this latter case, the pressure of the inlet air may need to be controlled to make it compatible with the requirements of the system.

[0009] The air inlet 10 leads to a combined coalescer and filter 11. The combined coalescer and filter 11 is best seen in Figures 2 and 3. Referring to those Figures, the combined coalescer and filter 11 comprises a bowl 30 closed at its upper end by a combined inlet/outlet 31. A liquid drain 12 is provided at the lower end of the bowl 30. These parts may, for example, be made of metal. The combined inlet/outlet 31 includes a central vertical outlet passage 32 surrounded by a vertical wall 33 having an initial generally straight portion 34 leading from an inlet 35 that is tangential to the succeeding semi-cylindrical portion of the wall 36. The wall then terminates in a further generally straight portion 37.

[0010] The bowl 30 encases a coalescer 38 and an HEPA filter 39. The coalescer 38 is an annular pleated element with an incorporated lint-like layer. The HEPA filter 39 is located within the core of the coalescer 38 coaxially therewith and may, for example, be formed by a pleated glass fibre material having a rating of, for example, 0.2 microns. The outlet passage 32 extends from the centre of the HEPA filter 39.

[0011] It will be appreciated that the coalescer 38 and the HEPA filter 39 are of conventional design and will not, therefore, be described in further detail.

[0012] The outlet passage 32 of the filter 11 connects with first and second inlet branches 14a,14b, each controlled by respective first and second inlet valves 15a, 15b. The first and second inlet branches 14a,14b lead to respective first and second pressure swing adsorbers 16a,16b. The first and second pressure swing adsorbers 16a,16b are preferably identical so only the first pressure swing adsorber 16a will be described; it being understood that the second pressure swing adsorber 16b is preferably similarly constructed.

[0013] The first pressure swing adsorber 16a comprises a housing 17a having an inlet 18a connected to the associated branch 14a and an outlet 19a. Adjacent the outlet 19a is a layer of mesoporous carbon 20a. Preferably, this is the mesoporous carbon 20a sold under the trade name BAX 1100, although other mesoporous carbons may be used.

[0014] In this specification, the term "mesoporous carbon" refers to porous carbon material in which the pores have an average diameter of between 20Å and 500Å. It will be appreciated that this does not exclude some of the carbon being microporous or macroporous but requires simply that, considered overall, the carbon is broadly mesoporous.

[0015] After the layer of mesoporous carbon 20a, there is a layer 21a of 13X Zeolite, although other adsorbents may be used. The adsorbent material is in the form of beads or pellets which may be bonded to one another by a polymeric binding agent, such as polyethylene. The construction and operation of such adsorbents is described in more detail in, for example, GB-B-2238490 and so will not be described here in detail.

[0016] The first outlet 19a from the first pressure swing adsorber 16a and the second outlet 19b from the

swing adsorber 16 is to provide sustained protection against the NBC agent since, if the water content of the pressure swing adsorber 16 continues to increase, it will become saturated with water vapour and will lose its capacity for adsorbing agents and simulants which will then begin to pass into the outlet gas. The results obtained by weighing correlated with the observation that the dewpoint of the outlet air remained low (<-50°C) throughout all the tests.

[0036] During the tests, the pressure swing adsorber 16 was periodically purged using unpressurized air as described above. The test showed that the pressure swing adsorber 16 desorbed the bulk of the retained NBC agents during normal operation. The results demonstrated that the adsorber could be operated in the pressure swing adsorption mode for extended periods of time without compromising the working capacity of the adsorber 16. Thus, the ability of the pressure swing adsorber 16 to defeat challenge with agents and simulants over sustained periods of operation did not depend on the use of the thermal clean-up cycle.

[0037] The test also included a clean-up cycle using heated air at a temperature of about 180°. The test showed that this clean-up cycle removed contaminants that were not desorbed during the cycling of the pressure swing adsorber 16. On the basis of the sustained challenges to which the pressure swing adsorber 16 was exposed, and an analysis of the results of the clean-up cycle, the tests assessed the regeneration of the pressure swing adsorber 16 as resulting in the restoration of the adsorption capacity to at least 98% of its initial value. This small reduction in capacity, which was difficult to quantify accurately, was thought to be due to the presence of a small percentage of microporosity in the mesoporous carbon 20, which traps higher boiling point components. This small reduction has no impact on the performance of the pressure swing adsorber 16 so that the working capacity of the adsorber 16 is unaffected.

[0038] These tests demonstrate that the system described above with reference to the drawings offers the capability to provide broad band protection against a range of NBC hazards under worldwide conditions of meteorology. It also has the ability to protect against the threat from toxic industrial chemicals and battlefield contaminants.

[0039] As described above, the apparatus includes two pressure swing adsorbers 16a,16b, each having two layers, a layer of mesoporous carbon 20a,20b and a layer of 13X Zeolite molecular sieve 21a,21b. The mesoporous carbon layers 20a,20b adsorb higher boiling point NBC agents while the 13X Zeolite 21a,21b adsorbs the lower boiling point agents. It will be appreciated, however, that the mesoporous carbon 20a,20b could be separate from the 13X Zeolite 21a,21b and be subjected to a separate purge. In addition, the higher boiling point NBC agents could be removed by a material other than mesoporous carbon and the lower boiling point agents could be removed by a material other than 13X Zeolite, although tests so far have shown mesoporous carbon and 13X Zeolite to be the most efficient materials for these purposes.

[0040] It will be appreciated that, while the system described above with reference to the drawings has two pressure swing adsorbers 21a, 21b, there may be more than two such adsorbers. For example, there may be three such adsorbers or, for larger applications any multiple of two or three adsorbers.

Claims

1. A method of removing chemical and biological agents from air for breathing by humans comprising removing higher boiling point agents from the air and then passing the air through an adsorbent in a pressure swing adsorber (16a,16b) to remove lower boiling point agents and water vapour.

2. A method according to claim 1 wherein the higher boiling point agents are removed by passing the air through a carbon filter (20a,20b).

3. A method according to claim 2 wherein the carbon of the carbon filter (20a,20b) is mesoporous carbon.

4. A method according to any one of claims 1 to 3 wherein the pressure swing adsorber (16a,16b) includes a 13X Zeolite.

5. A method according to claim 2 or claim 3, wherein the carbon filter (20a,20b) forms a first layer of the pressure swing adsorber (16a,16b), the adsorbent (21a,21b) of the pressure swing adsorber forming a second layer.

6. A method according to any one of claims 1 to 5 and including periodically performing a temperature sweep of the pressure swing adsorber (16a,16b) to desorb matter held by the pressure swing adsorber (16a,16b) and pass the matter to waste.

7. A method according to any one of claims 1 to 6 and comprising filtering the air prior to the removal of the higher boiling point agents to remove particulates.

8. A method according to any one of claims 1 to 7 and comprising removing liquid aerosols prior to the removal of the higher boiling point agents.

9. A method according to any one of claims 1 to 8 wherein first and second pressure swing adsorbers (16a,16b) are provided connected in parallel, the pressure swing adsorbers (16a,16b) being cycled so that the first pressure swing adsorber (16a) is adsorbing while the second pressure swing adsorber (16b) is being purged and vice versa.

10. A method according to claim 9 wherein the cycle time is less than 10 seconds, preferably 8 seconds.

11. A system for removing chemical and biological agents from air for breathing by humans comprising means (20a,20b) for removing higher boiling point agents from the air, and a pressure swing adsorber (16a,16b) for receiving air from the removing means and including an absorbent (21a,21b) for removing lower boiling point agents and water vapour from the air.

12. A system according to claim 11 wherein the means for removing higher boiling point agents comprises a carbon filter (20a,20b).

13. A system according to claim 12 wherein the carbon filter is a mesoporous carbon filter (20a,20b).

14. A system according to any one of claims 11 to 13 wherein the adsorbent of the pressure swing adsorber (16a,16b) includes a 13X molecular sieve (21a,21b).

15. A system according to any one of claims 11 to 14 where dependent on claim 12 wherein the carbon filter (20a,20b) forms a first layer of the pressure swing adsorber (16a,16b), the adsorbent (21a,21b) of the pressure swing adsorber forming a second layer.

16. A system according to any one of claims 11 to 15 and including means for supplying heated air to the adsorber to perform a temperature sweep of the pressure swing adsorber (16a,16b) to desorb matter held by the pressure swing adsorber (16a,16b) and pass the matter to waste.

17. A system according to any one of claims 11 to 16 and including means (11) for filtering the air to remove particulates, said means being arranged before the pressure swing adsorber (16a,16b) in the direction of flow of the air.

18. A system according to any one of claims 11 to 17 and including means (11) for removing liquid aerosols, said means (11) being arranged before the pressure swing adsorber (16a,16b) in the direction of flow of the air.

19. A system according to claim 17 or to claim 18 when dependent on claim 17 wherein the means for filtering the air and the means for removing liquid aerosols are formed by a single HEPA filter (11).

20. A system according to any one of claims 11 to 19 wherein a second removing means (20b) and a second pressure swing adsorber (16b) are provided, control means (31) being provided for cycling the first mentioned and the second removing means (20a,20b) and the first mentioned and the second pressure swing adsorber (16a,16b) so that the first-mentioned removing means (20a) and the first-mentioned pressure swing adsorber (16a) remove agents from air while the second removing means (20b) and the second pressure swing adsorber (16b) receive purge air to regenerate the second removing means (20b) and the second pressure swing adsorber (16b) and vice versa.

21. A system according to claim 20 wherein the control system controls the cycle time to less than 10 seconds, preferably 8 seconds.

Fig.1.

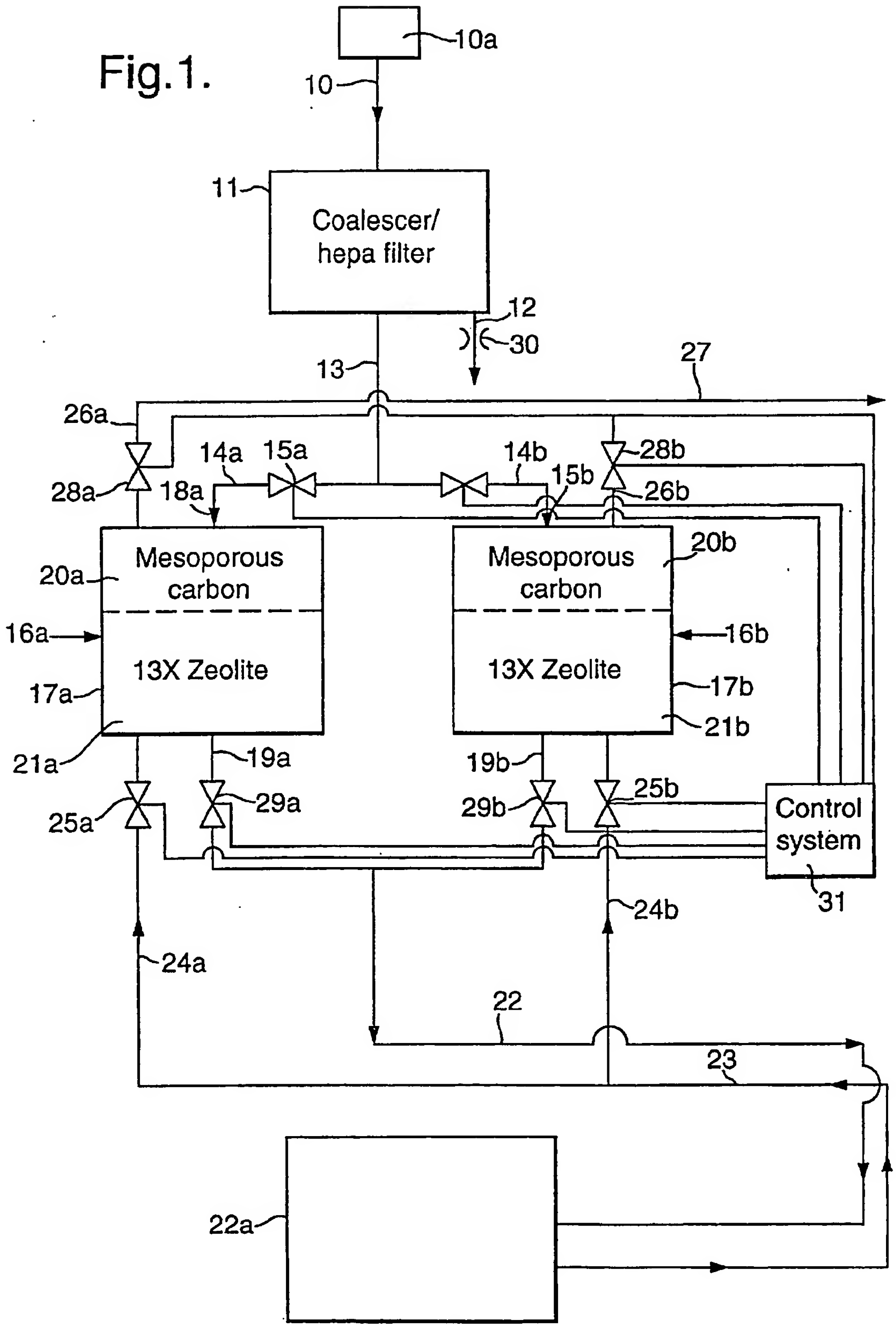

10a
10
11
Coalescer/
hepa filter
12
30
13
27
26a
28b
14a
15a
14b
15b
28a
18a
26b
20b
Mesoporous
carbon
Mesoporous
carbon
20a
16a
16b
13X Zeolite
13X Zeolite
17a
17b
21b
21a
19a
19b
25b
29a
29b
Control
system
25a
31
24b
24a
22
23
22a

Fig.2.

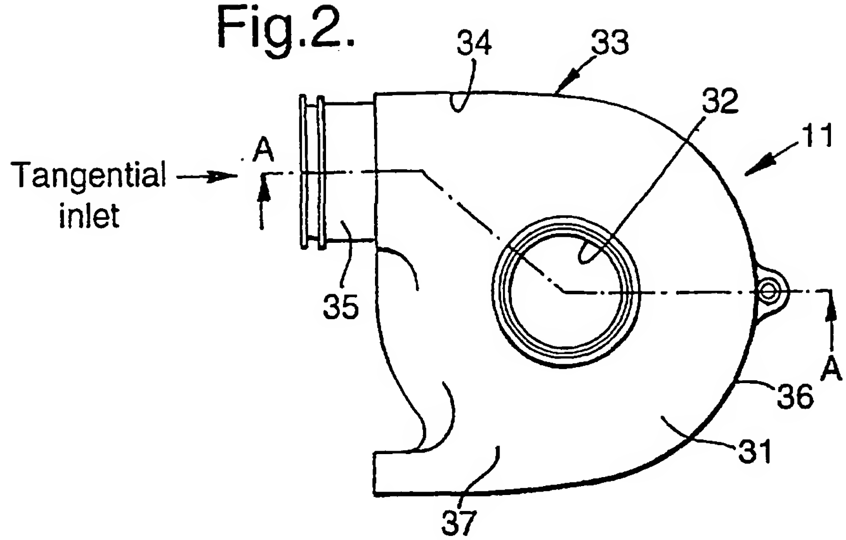
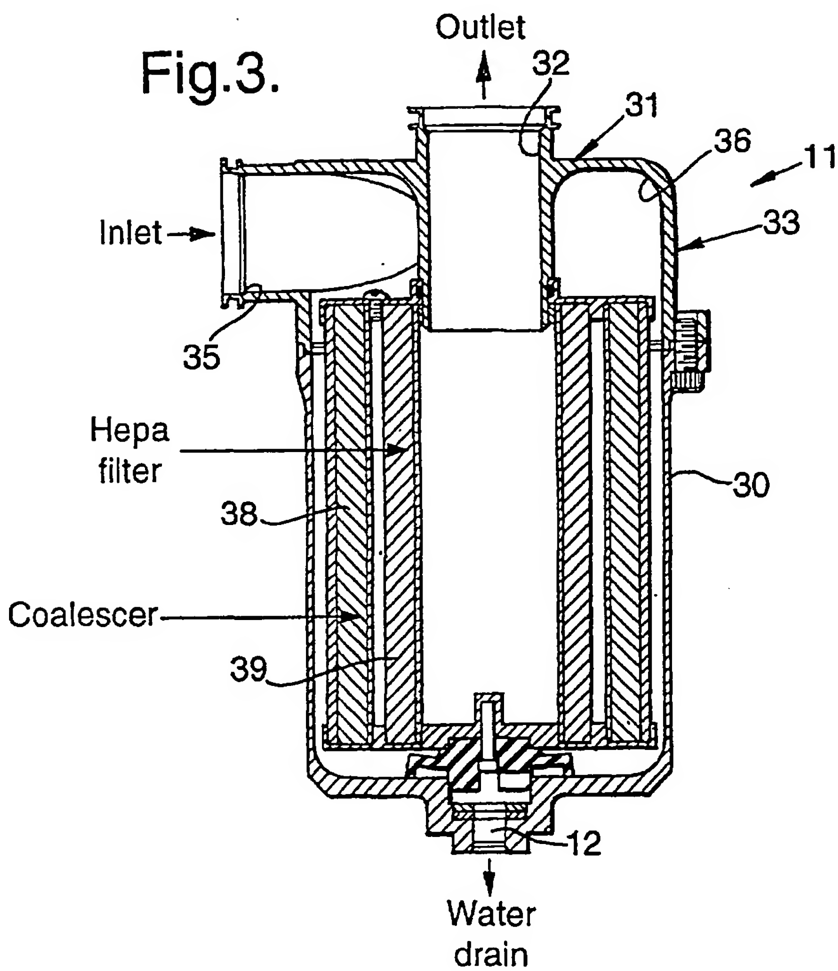

34
33
32
11
A
Tangential inlet
35
36
A
31
37

Fig.3.


Outlet
32
31
36
11
Inlet
33
35
Hepa filter
30
38
Coalescer
39
12
Water drain

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 30 4213

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 August 2001	Doolan, G

CATEGORY OF CITED DOCUMENTS

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